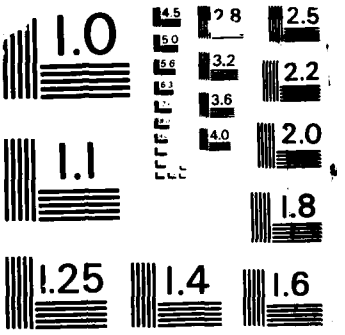
AD-A181 167 STRENGTH AND STRUCTURE OF GA(1-X)IN(X)AS ALLOYS(U) OHIO 1/1
STATE UNIV RESEARCH FOUNDATION COLUMBUS
K T FABER ET AL 15 APR 87 AFOSR-TR-87-0735
UNCLASSIFIED F49620-85-C-0129 F/G 7/2 NL



MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

(2)

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SECURITY CLASSIFICATION OF THIS PAGE

AD-A181 167

DOCUMENTATION PAGE

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12. PERSONAL AUTHOR(S): Katherine T. Faber and John P. Hirth

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Substantial solid solution strengthening of ~~GaAs~~ by In acting as ~~InAs~~ units has recently been predicted for an intermediate temperature, plateau region. This strengthening could account, in part, for the reduction of dislocation density in GaAs single crystals grown from the melt. High temperature deformation measurements have been carried out on GaAs and $Ga_{0.99}In_{0.01}As$ from 700 to 1100°C in the [123] orientation. In this single slip orientation, the critical resolved shear stress of the In-doped material is nearly twice that of the undoped material. Values of the critical resolved shear stress are weakly dependent on temperature, consistent with the solid solution hardening model. The observed increase in resistance to glide is sufficient to eliminate dislocations in large diameter crystals during growth. Electron microscopy is used to relate the mechanical properties of these materials to their dislocated structures.

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RF Project 764977/717636
Quarterly Report

AFOSR-TR- 87-0735

STRENGTH AND STRUCTURE of $Ga_{1-x}IN_x$ AS ALLOYS

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For the Period
January 1, 1987 - March 31, 1987

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH
Building 410
Bolling AFB, D.C. 20332-6448

Contract No. F49620-85-C-0129

April 1987

OSU
The Ohio State University Research Foundation
1314 Kinnear Road
Columbus, Ohio 43212

The strengthening effect of gallium arsenide by indium additions is under examination. Interpretation of high temperature hardness results of In-free and In-containing GaAs suggests that the intermediate temperature hardening of these materials may be sufficient to reduce dislocation densities by two orders of magnitude during growth. The second quarterly report describes the most recent mechanical tests and electron microscopy in this study to better understand the solid-solution strengthening in these systems.

(1) Progress

Compression tests on LEC grown semi-insulating undoped and In-doped GaAs single crystals have been completed in the [123] orientation in the temperature range 700 to 1100°C. The [123] orientation allows deformation via a single slip system. The In-doped materials had an In concentration of 2×10^{20} cm^{-3}. For both materials, the linear region of the stress-strain curve results in a lower-than-anticipated elastic modulus, indicating the occurrence of micro-creep. The slope is significantly smaller for undoped materials, suggesting a higher creep resistance for In-doped materials.

Both undoped and In-doped materials showed the presence of an easy glide region in this single slip orientation. However, the critical resolved shear stress (CRSS) for the In-doped material was nearly twice that of the undoped material. This observed increase in the resistance to glide is sufficient to eliminate dislocations in the growth of large diameter crystals. Values of the CRSS are weakly temperature

dependent, consistent with the solid solution strengthening model proposed.

In Stage III of the deformation, higher stress values for the onset of dynamic recovery show that dislocation climb is slowed by the Indium doping.

Transmission electron microscopy studies of deformed In-doped and undoped [100] GaAs are complete. Specimens deformed at 900 and 1100^{o}C show complex defect structures due to multiple slip. Perfect as well as partial dislocations forming dislocation networks have been observed. However, dislocation loops, prevalent in specimens deformed at 700^{o}C, were rare in the 1100^{o}C samples. A detailed analysis of the dislocation structures and their interaction mechanism is in progress. An estimate of the stacking fault energy will be performed on these specimens by measuring the width of the partial dislocations in the deformed specimens. Furthermore, TEM studies of deformed materials in the single slip orientation, [123], will be performed.

(2) Special equipment purchased or constructed

None.

(3) Changes in key personnel

None.

(4) Substantive information derived from meetings

Materials for study are continuing to be supplied by Dr. Noel Thomas of Westinghouse R&D Center. Discussions with Dr. Thomas' group take place on a bimonthly basis.

Undoped GaAs grown by the Bridgman technique has been

ordered from Crystal Specialties, Inc. for comparative studies. In addition, Dr. Arati Prabhakar from DARPA has requested high purity Bridgman crystals from Bell Laboratories for our studies.

(5) Problems of concern

None.

(6) Fiscal Status

(a) Amount currently provided for contract: $289,268.00

(b) Expenditures and commitments to 12/31/86: $165,387.28
March financial statement attached.

(c) Amount needed to complete work: $123,880.72

(d) Estimated date of completion: 8/31/87

DEPT 1420 — PRINCIPAL INVESTIGATOR(S): KATHERINE T FABER, JOHN P MIRTH

THE OHIO STATE UNIVERSITY RESEARCH FOUNDATION
PROJECT FINANCIAL SUMMARY
FOR MONTH ENDING MAR 31, 87

START DATE 9/01/85 — END DATE 8/31/87 — PROJECT 717636

AF OFC SCI RES
F49620-85-C-0129

MASTER PROJECT 764977

********** SPONSOR SUPPORT COSTS **********	BUDGET	EXPENDITURES THIS MONTH	EXPENDITURES TO DATE	COMMITMENTS	UNENCUMBERED BALANCE
SALARIES AND WAGES - RELEASE TIME	27,868.00	2,358.40	17,297.56	3,537.60	7,032.84
SALARIES AND WAGES - ROTARY TIME	108,942.00	4,510.00	63,276.74	13,530.00	32,135.26
FRINGES - RELEASE TIME	4,882.00	406.82	3,082.58	495.26	1,304.16
FRINGES - ROTARY TIME	24,707.00	678.90	9,373.25	1,854.97	13,478.78
TOTAL PERSONNEL COSTS	166,399.00	7,954.12	93,030.13	19,417.83	53,951.04
REPORTS, REPRO, REPRINTS			418.80		418.80-
PURCHASED SERVICES	1,000.00	371.40	5,509.86	1,383.40	5,893.26-
SUBCONTRACTS	4,000.00				4,000.00
MATERIALS AND SUPPLIES	19,595.00	457.91	6,966.40	860.00	11,758.60
OTHER DIRECT COSTS	415.00	27.54	785.05		370.05-
EQUIPMENT PURCHASE	7,885.00		7,937.22		52.22-
TRAVEL - DOMESTIC	4,000.00		2,824.75		1,175.25
TOTAL DIRECT COSTS	203,294.00	8,810.97	117,472.21	21,661.23	64,150.56
INDIRECT COSTS	85,984.00	3,788.72	47,915.07	9,314.33	28,754.60
TOTAL SPONSOR SUPPORT COSTS	289,268.00	12,599.69	165,387.28	30,975.56	92,905.16

ACCOUNT REC NO		OSU COST SHARING GUARANTEED	TO DATE	SPONSOR + OSU EXPEND TO DATE	IND COST RATES		DEV OFFICER
					G 44	43.00 .00	WOUDY
060006	AMOUNT			165,387.28			PROJ ADMIN
5	PERCENTAGE						VENTRESCA

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